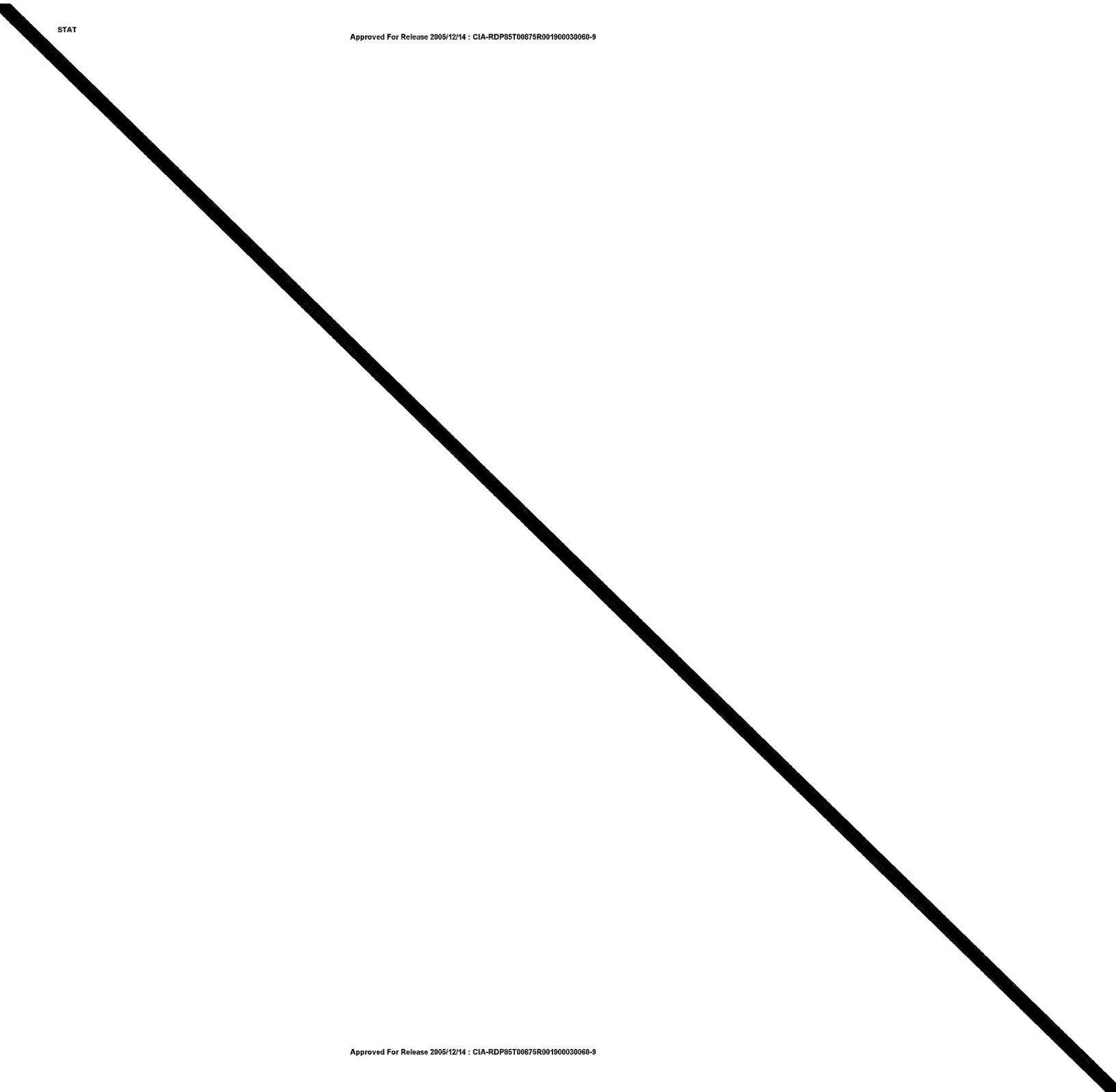

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BANGLADESH: The Foodgrain Outlook Through 1985

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BANGLADESH: The Foodgrain Outlook Through 1985

Objectives

The objectives of this paper are to assess past and prospective Bangladesh agricultural development and, on the basis of this assessment, to forecast the probable 1985 gap between foodgrain production and requirements.

Conclusions

Bangladesh agriculture responded favorably during the 1960s when the Pakistan government increased investment in its east wing. Peak foodgrain production rose from 8.4 million tons during the 1950s to 12.1 million tons in FY 1970. After severe setbacks in foodgrain production as a result of natural disasters and the civil war, foodgrain production in FY 1974 recovered to its FY 1970 level. Demand has continued to increase and imports rose to 2.9 million tons in FY 1973 before falling to 2.1 million tons last year.

Dacca will have to give agriculture much more attention if the growth rate of the 1960s is to be maintained. Moreover, accelerated growth must be attained if the gap between demand and domestic production is not to widen over the next decade.

The pressure of population growth on Bangladesh's agricultural resources has been growing at an increasing rate. No significant decline is in sight. Death rates have fallen

sharply, but family planning measures have had virtually no impact. Budgetary support for birth control programs is minimal. Demographers foresee little change in the birth rate and project a 1985 population exceeding 115 million.

Clearly, there is good potential for raising agricultural production. For example, Bangladesh ranks among the world's lowest in fertilizer application; irrigation can add six million acres to planted area in the dry season; and less than 15% of cultivated land is under high yielding varieties (HYV) of grains.

There are also substantial obstacles to the realization of Bangladesh's agricultural potential. Only since 1971 has Dacca had control over agricultural policies, and administrative experience is scarce. Dacca is likely to bow to expediency, adopting a patchwork of measures having limited impact. Areas that require particular attention include:

- Reduction in the population growth rate through vigorous family planning programs.
- More rapid development of irrigation, especially of intensive systems capable of supporting the multiple cropping of HYVs.
- Flood control to protect farmland and reduce the annual variation in rice production.
- Massive improvement in the production and distribution of HYV seeds, fertilizer, and other agricultural inputs.

- Expanding agricultural credits and giving a larger share to small farmers.

We believe that the Bangladesh government could formulate and implement policies that would significantly reduce food-grain imports by 1985. In the light of past performance, however, this is an unlikely achievement. We believe Bangladesh's agricultural policy will continue to be sporadically responsive to production shortfalls.

Unless government performance changes dramatically, the 1985 gap between production and domestic demand appears likely to fall within a range of 3 million to 4 million tons. Then, as now, Bangladesh will have great difficulty financing imports to close that gap.

I. Background

A. The Agricultural Scene

Agriculture is Bangladesh's most important economic activity, contributing about 60% of gross domestic product (GDP), compared with 9% for manufacturing. More than three-quarters of the people are farmers. Nonetheless, Bangladesh is unable to feed its 80 million people and requires imports of 10% of total foodgrain consumption in normal years and up to 20% in poor years. Increasing domestic production is difficult and costly because all available land is already cultivated. Most farmers grow little more than enough to feed their own families. Production methods are primitive, farmers are burdened with debt, and yield per acre is among the lowest in the world. Poverty hinders the adopting of improved agricultural methods. Many seek not the largest crop but the surest one.

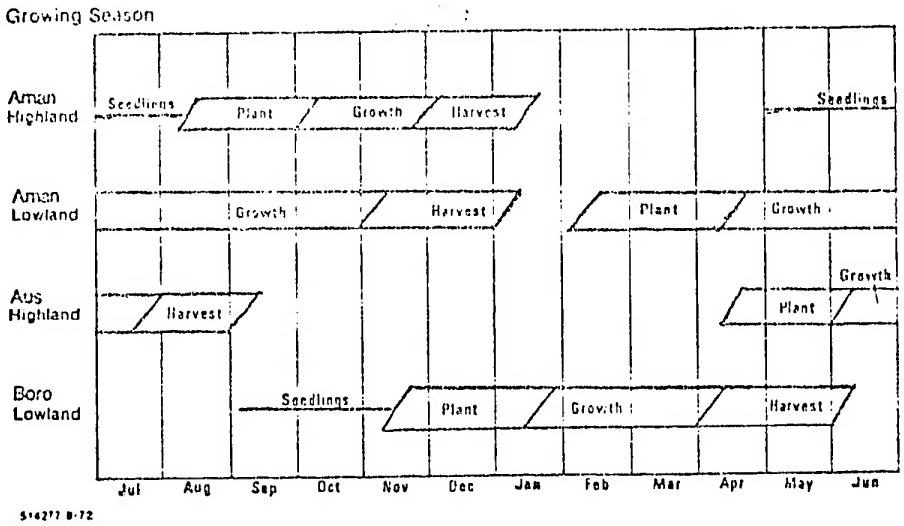
Rice is the mainstay of the diet and is grown almost to the exclusion of other cereals. Rice yields are largely influenced by the timing of rainfall and inundation. Two of the world's largest rivers, the Ganges and the Brahmaputra, flow through Bangladesh, and a third -- the Meghna -- flows from Assam, the wettest part of India. The total annual flow of these rivers and their tributaries is twice that of the Mississippi. The summer monsoon deposits from 50 to 150 inches of rainfall, usually flooding vast areas and sometimes

causing widespread crop and property damage. In October the rains stop, the land drains, and the rivers shrink. Generally, by February, drought conditions set in, and until May irrigation is required for crop growth. This hydrological cycle makes it necessary to employ both flood control and irrigation systems to realize the regions' agricultural potential.

The soil is fertile, and the climate permits plant growth throughout the year. There are three seasons a year in which rice can be cultivated, but they overlap to some extent so that the same land cannot carry all three. The three annual rice crops are (a) the aus harvest in July and August, (b) the aman harvest in November and December; and (c) the boro harvest in April and May (see Figure 1). They represent about 20%, 60%, and 20%, respectively, of rice output. The aman crop is grown practically throughout the country in both highlands and lowlands. It is sown earlier on lowlands to permit sufficient growth to withstand inundation by monsoon floods. The aus crop also is widespread, but has a shorter season and is limited to highlands to avoid monsoon flooding. The boro crop, grown during the dry season, is limited by irrigation requirements and is grown mainly in the marshy northeast.

Figure 1

Bangladesh: Growing Seasons of Rice Crops



B. The Human Environment

The average land-owning villager possesses only 1.5 acres. He rents another acre from the well-to-do villagers and therefore cultivates 2.5 acres. This area is usually fragmented into ten or more plots, some of which may be a mile or more away from the homestead. He owns one scrawny cow for ploughing. The plow is a light 15 pound rig, which turns only two or three inches of soil. The principal family resource is the rice kept for consumption, the product from about two acres. Since the usual rent of rice land is 50% of the crop, the average villager will get little more than enough produce to feed his family and finance a few purchases of clothing, cooking oil, etc. If he becomes indebted to money lenders, he

barely manages interest payments, and an occasional bad year puts him even deeper into debt.

The lives of the one-tenth of village laborers who are landless are even more grim. They are at the mercy of the landowners and are often evicted after a bad harvest. They earn two meals of rice and 25¢ to 35¢ a day during the peak of planting or harvesting season. In slack periods hardly one in four will get a job, and even then for only 20¢ a day and no meals. During the slack season, therefore, the desparate jobless often travel 100 miles or more to public construction projects providing some employment. At planting or harvesting time, they move back to their home areas.

C. Production Since 1948

Foodgrain output increased an average of 2.5% annually between FY 1948 and FY 1970, ending with peak output of 12.1 million metric tons in the last year (see Table 1). Most of the increase came during the 1960s, however, when output expanded at 3.4% per year compared with virtual stagnation during the previous decade. Both acreage and yields expanded rapidly during the latter decade largely because of the increasing importance of the boro crop. Expansion of irrigation facilities allowed for a doubling of boro acreage during the decade (see Table 2). The introduction of high yielding varieties of rice in the mid-1960s was also concentrated in the

boro crop causing yields to double (see Table 3). Expansion of the aus and aman crops has been limited by the lack of adequate control of monsoon flooding. HYV rice demand more precise water control than traditional varieties. In FY 1972 HYV rice contributed 6%, 15%, and 52%, of the rice output of the aus, aman, and boro crops, respectively.

Rice production reached 12.0 million tons in FY 1974 according to the Agricultural Minister, but other expert observers estimate output at 12.3 million to 12.5 million tons. Even the government's lower estimate represents a 19% increase over the preceeding year and signifies a recovery to pre-independence production levels. But with more mouths to feed, per capita production still has not recovered completely. Production during FY 1971 and FY 1973 was reduced by the cyclone of November 1970, the civil war of 1971, and the poor 1972 monsoon.

Rice production has been inadequate to feed the population since the 1930s. During the 1950s East Pakistan slipped from near self-sufficiency in foodgrains to becoming a large importer as population growth accelerated while rice production stagnated (see Table 4). Even when rice production began increasing more rapidly during the 1960s, East Pakistan's food-grain imports continued to rise, especially when floods or drought reduced domestic production.

The 1974 monsoon has been heavy through the third week of August bringing unusually severe flooding, especially in the eastern areas. An assessment of the crop damage cannot be made with any degree of accuracy before September. The government had earlier projected FY 1974 foodgrain imports at 1.7 million tons, of which at least 500,000 tons have already been arranged.

D. Government Policy

In its First Five Year Plan (FY 1974-78), Dacca has set a goal of foodgrain self-sufficiency by the last year of the Plan. Rice production is to sustain a growth rate of over 6% annually -- un unprecedented rate. In addition, wheat output is to grow 32% per year. To accomplish such growth, Dacca is to undertake massive programs to expand irrigation, control annual flooding, increase HYV rice acreage, expand rural credit institutions, and improve availability of fertilizer, pesticides, and herbicides. One-quarter of the development budget has been allocated to agriculture and related sectors. Considering the meager resources available and the problems confronting agriculture, however, Bangladesh will be fortunate if foodgrain production simply keeps pace with population growth and the foodgrain deficit does not increase.

The government's foodgrain distribution system was re-established and expanded by the UN following independence,

but its administration has since been returned to the government. Official foodgrain stocks are distributed through government fair price shops -- specially licensed small private stores. Foodgrains and other essential commodities are sold to ration card holders in fixed amounts and at set prices. Statutory rationing exists in four main cities -- Dacca, Khulna, Chittagong, and Narayanganj -- where minimum foodgrain needs are provided to everyone -- about 6 pounds weekly per adult. All other towns and rural food deficit areas have a modified ration system in which only the poorer segment of the population is issued ration cards and provided foodgrains. Substantial quantities of foodgrains are also issued under relief in the event of natural calamities or acute economic distress.

Almost all of the grain for the ration shop system comes from imports. Although the government buys rice in the local markets, mainly from the aman crop, its acquisitions have fallen short. From the last aman crop, the government procurement target was 400,000 tons, but only 67,000 tons were obtained because government agents offered prices substantially below free market price.

The government's subsidized consumer programs do not conflict with its subsidies to grain growers. Ration shop prices are kept artificially low to retard cost of living increases, and the high cost of imported foodgrains is absorbed by the

government. The low procurement price for rice, however, is not a disincentive to domestic production because of the strong demand in the free market. Agricultural inputs are also subsidized. In 1973 subsidies amounted to 19% for urea, 57% for phosphates, 55% for potash, 80% for irrigation pumps, and pesticides were usually distributed free. The incentive provided by subsidizing agricultural inputs is difficult to determine in a country where three-quarters of foodgrain output is consumed by the grower.

Shortage of foodgrains is one of the major causes of Bangladesh's continuing inflation. The price of rice has doubled since independence, but rose only about 20% last year because of increased production. The government has committed itself to holding the general price rise in FY 1975 below 10%, but achievment of this goal is unlikely. Along with actions in other sectors of the economy, Dacca has cut the subsidies on rationed foodstuffs, fertilizers, and pesticides. Last May, ration prices for rice and wheat were increased 33% and 44%, respectively.

Because of the high price of rice in India and a black market currency exchange rate favoring the Indian rupee, there is significant smuggling of rice from Bangladesh to India. No one knows how much, but informed estimates range from 200,000 tons to 500,000 tons annually. To combat smuggling, Dacca discontinued

free trade with India in its border areas. Dacca requires also that the entire rice production from the husking mills within ten miles of the border be sold to the government. Enforcement is difficult, however.

II. Factors Affecting Future Demand

While there is substantial disagreement on the level of its present population, there is no doubt that Bangladesh is the world's eighth most populous nation. Our estimate of population is based on several assumptions, all of them conservative:

- Population as of July 1970: 73.3 million
  (Range of estimates; 71.5 - 77.5 million)
- Population growth rate: 3.0%
  (Range of estimates, 2.9 - 3.5%)
- Fatalities in November 1970 cyclone: 300,000
  (Government of Pakistan estimate: 250,000)
  (Bangladesh claims of 500,000 appear inflated for political reasons)
- Fatalities in war for independence: 1.5 million
  (Bangladesh claims of 3 million appear inflated for political reasons)
- War refugee exodus to India: All forced to return.

On the basis of these assumption, we estimate Bangladesh's mid-1974 population at 80.8 million.

Dacca estimates present annual growth rate of population at 3.09% and has hopes for reducing this rate substantially by 1985. Most demographers believe present population growth is closer to 3.3% and that there is little chance of reducing it significantly by 1985 especially since nearly half of the population is less than 15 years old. If population grew at 3.09% per year, it would reach 112.9 million in mid-1985. At 3.3% per year, population would reach 115.5 million. There is no precedent for a population of this magnitude living in an essentially rural environment in an area the size of Louisiana.

Dacca has a small family planning program, but admits that almost nothing has been accomplished since independence. Many Bengalis considered Pakistan's emphasis on family planning before independence as a political weapon to reduce East Pakistan's population relative to that of West Pakistan. Not only are government birth control programs insufficient, but also the pre-conditions for success of such programs do not yet exist. Although religion is not an obstacle to birth control, tradition and economics are. A large family is a form of social security and parents, aware of the high rate of child mortality, continue to have children until at least one son grows to manhood. The low level of literacy and economic development also hampers the success of any birth control program. These conditions are not likely to change rapidly in Bangladesh, where over 90% of the

population lives in rural areas where they are engaged principally in subsistence agriculture.

The quality of the average diet is very low and malnutrition is endemic. While most of the rural population subsists on what they grow, the average urban wage-earning family spends about two-thirds of its budget on food. Consumption of leafy vegetables and meat is low, but abundant fish provide some protein. In most homes, only non-perishable foodstuffs can be stored. Thus, foodgrains account for some three-quarters of the calories and 70% of the protein in the diet. There is almost no margin for decreasing per capita consumption, so declines in foodgrain availability could be disastrous.

In general, Bangladesh's population can be considered immobile, but the few cities provide a strong attraction for the rural population. When times become harder in the rural areas, because of drought, flood, or cyclone the flow to the cities becomes a torrent. In Bangladesh's three largest cities since 1961, Dacca's population has risen 193%, Khulna 439%, and Chittagong 139%. Despite rapid expansion, less than 10% of the population lives in urban areas. There is also some illegal migration into India. Its magnitude is dependent on the current conditions in Bangladesh. Although a headache for India, the present migration is far less than has occurred during several periods since 1947.

The continuing migration to the cities complicates the feeding and employment of the population. The Bangladesh government pays a disproportionate amount of attention to its urban populations, partly because of their great density, and partly because city dwellers are often more sophisticated and politically active. Low incomes and high unemployment make the cities potential trouble spots. To feed large urban populations requires complex food distribution systems, unnecessary in rural areas.

Another element affecting future foodgrain demand is the price and income elasticity of demand -- the degree to which changes in the price of foodgrains and average income will affect demand for foodgrains. Two factors led to the exclusion of price elasticity from consideration:

- Since foodgrains make up such a large part of the diet and substitutes are scarce, it is reasonable to assume that price elasticity of demand is low.
- There is no reliable method for predicting changes in the Bangladesh price structure over the next decade.

Therefore, it is assumed that the price structure remains basically unchanged.

The income elasticity of demand for foodgrains, on the other hand, cannot be ignored because per capita income levels

probably will change significantly over the next decade. Sample measurements of income elasticity in Bangladesh in the period FY 1967-69 by the Harvard University Center for Population Studies, using several different methods of calculation, range from .32 to .40. (An income elasticity of .35 means that for each 1% increase in per capita income, the demand for foodgrains would increase 0.35%.)

III. Factors Affecting Future Supply

A. Weather and Climate

Foodgrain production will continue to be largely dictated by rainfall and flooding. Rainfall changes during any one year can drop foodgrain output by 10% or more. Likewise, highly favorable weather for a few years raises output rapidly. Nevertheless, output projections for even one year, much less for 10 years, must be made with the assumption of normal or average weather, because there is no reliable methodology for predicting weather patterns at present. The world's climatologists have theories and are developing techniques, but none is advanced enough to be reliably applied to Bangladesh.

The next most important determinant of foodgrain production is the annual flood, which occurs sometime during the monsoon. Two-thirds of the cultivated area is inundated to a depth of more than one foot, one-third to a depth of three feet, and

about 15% to a depth of more than six feet. Villagers are accustomed to such "normal floods" and their crops are adapted to it. The uncertainties of timing, duration, extent, and depth of floods result in considerable crop losses, as well as property damage. Early floods ruin young rice plants in the fields or destroy seed beds. If the flood is late and persists while the rice is in flower, yields fall sharply. Floods usually rise and fall fairly quickly, but if they stand over four days, many rice plants are destroyed. If the flood is too deep, short-stemmed rice plants on relatively high ground will drown. If the flood is not deep enough, rice on the high ground will not get sufficient moisture.

Cyclonic storms are another threat, sometimes even more damaging than the annual floods. Tropical storms moving up the Bay of Bengal, frequently batter the coastal regions and/flat the delta terrain is defenseless against the tidal waves that often accompany them. The strong winds and heavy rains can flatten rice fields for 50 to 100 miles inland. Crop damage and loss of life caused by cyclones has worsened as population pressure forces more people into the vulnerable coastal area. A government program to reduce salt water damage to coastal croplands was started in 1959. Over 2,200 miles of embankments have been built.

The development of water resources in Bangladesh has lagged behind that of the rest of the subcontinent for two main reasons. First, agricultural production met the needs of the people until the 1930s. Second, the development of water resources, whether by irrigation of dry lands or by protection and drainage of flooded lands, is relatively expensive and technically complex in the Bangladesh environment.

B. Agricultural Inputs

Accelerating foodgrain output depends heavily upon raising rice yields by increased use of HYVs, fertilizer, and pesticides. The potential for raising yields of traditional varieties is quite limited. The latter are relatively tall, weak-stemmed plants. Abundant application of fertilizer produces heavier heads causing the plants to fall over or lodge. Increased rice yields, therefore, require a major modification in rice cultivation.

HYV rice, originally developed by the International Rice Research Institute in the Philippines, has shorter and stronger stems capable of holding much larger heads. Yields double that of traditional varieties are common with proper care. While HYV rice opens up enormous production possibilities, it is definitely not "miraculous." It requires difficult adjustments in institutions and cultural practices if full benefits are to be reaped. Pest control, weed control, better land preparation,

controlled irrigation, proper timing in transplanting, and appropriate use of fertilizers are all necessary to take advantage of the new technology. This implies a heavy burden on research, extension and educational service.

One of the original HYV rice varieties, IR8, was introduced in 1966 for use in the boro and aus crops. But IR8 was not popular because of poor taste and milling qualities, susceptibility to local diseases, and a relatively long growing period that made it difficult to fit into the normal seasonal cultivation pattern. The newer IR20 variety, introduced in 1970, overcame most of these difficulties. IR20's short growing period increases the possibilities for double and triple cropping. On the negative side, IR20 can only withstand inundations of up to one foot and therefore, is unsuitable for growth during the monsoon season except in relatively high areas. Despite encouraging results, especially in the boro crop, adoption has been slow because of the civil war and the persisting economic dislocations. The government's Rice Research Institute near Dacca is developing hybrids with traditional varieties that will stand deep inundation. Some progress has been made on new varieties that can be used in the aus crop, but none have been developed that grow under the deep flood conditions of the aman crop.

Use of manufactured fertilizer in Bangladesh has always been extremely limited. Silt deposited by the annual floods has kept the land fertile despite extensive cropping for centuries. But crop production can be enhanced greatly by application of fertilizers. In recent years, the average fertilizer dose has been 10 pounds of nutrient per acre -- less than 5% of the recommended level. Proper fertilization is essential to realize the full potential of HYV rice. As its use becomes more extensive, Bangladesh's fertilizer requirements will expand rapidly. The fertilizer program originally overemphasized the use of urea (nitrogen) to the exclusion of other fertilizers because of its availability from domestic production. Since the introduction of HYV rice, however, a more balanced use of nitrogen, phosphorous, and potassium has been achieved.

Bangladesh has two urea fertilizer plants, which use its abundant natural gas supplies. A third, financed by the World Bank, USAID, and others, is expected to increase productive capacity by about 75% by 1978. At that point the country will be able to meet its increasing demand for nitrogen fertilizer without imports. Two phosphate fertilizer plants are presently idle due to lack of raw materials, but will provide nearly 20% of consumption when production resumes. Potassium fertilizer requirements will continue to be met by imports. Distributing

and marketing fertilizer is a greater problem than production. Transportation from ports and district warehouses is deficient, and inadequate credit arrangements inhibit timely sales to farmers.

Plant protection measures are essential to averting large crop losses because insects, weeds and crop diseases flourish in the hot and humid climate. With the introduction of HYV rice, the returns from protective measures increase significantly. In 1970, only about one-third of the rice acreage received any pesticides, and most applications were scanty. Herbicides also are underutilized. Weeds take a heavy toll in reduced yields. Experiments are now being pursued to make the newer rice varieties more resistant to disease by cross-breeding with traditional varieties.

C. Multiple Cropping

To continue agricultural expansion beyond the next several years, new land must be brought under cultivation. While virtually all arable land is already cultivated, only 35% is cropped more than once a year. Labor is abundant and the climate is amenable to year-round plant growth. But monsoonal floods make expansion of acreage during the summer season possible only through extensive flood control and drainage facilities. Such projects are costly and require long leadtimes.

The main hope for expanding acreage lies with the dry season boro crop, which is confined to about 20% of the suitable acreage for lack of moisture. Groundwater is abundant but its utilization has lagged, partly because farmers expect plenty (if not too much) rainfall during the monsoon season and partly because of social and institutional restrictions. Fragmentation and the smallness of average holdings inhibit the effective use of tubewells. For a tubewell to be profitable it generally must irrigate at least 10 acres. Few rice farmers cultivate plots that large, or have the funds and willingness to consolidate with neighbors. Few attempts to organize cooperatives have succeeded. Nevertheless, the pace of groundwater development started to increase in 1966 to take advantage of the potential offered by the new HYV rice. By 1970, however, only one million of the 7 million acres suitable for production during the boro season were irrigated.

Other factors have seriously reduced total irrigated area since 1970. The 1971 civil war caused many tubewells to break down due to a lack of maintenance. Repair parts and facilities, always in short supply, are now often unavailable. Lack of diesel fuel and electric power shortages have idled many tubewells. By FY 1973, irrigated acreage had again reached the FY 1970 level. The government encourages the installation

of tubewells and low-lift pumps and subsidizes part of the annual cost of irrigation.

D. Institutional Barriers

The average farm size in Bangladesh is about 2.5 acres. Only 4% of the cultivated land is held in farms of 25 acres or larger. Thus, in the Bangladesh context, a 10-acre farm is very large. On the other hand, only about 10% of rural households are landless. For a land-poor country, the ratio of landless to landed households is strikingly low.

Distribution of ownership is not a good measure of the average size of a farmed plot because of extensive fragmentation of holdings. In 1960, 96% of all farm land was held in fragmented holdings. Today, it must be even more. Fragmentation of holdings has been carried to extremes. Over half of the farms are made up of at least six separate plots, and one-third have more than 10 plots. Rarely are these plots contiguous and often they are a mile or more apart. Land reform under such circumstances is a horrendous task that would be opposed by most farmers, who resent any change in traditional landholding patterns.

The introduction of new rice varieties and the accompanying need for other agricultural inputs is putting a severe strain on the structure of agricultural credit. Consequently, the government is attempting to expand credit institutions in rural

areas. About 15% of rural credit now comes from institutional sources and the rest comes from private moneylenders. Studies suggest that not all credit needs are being met and that over half of rural credit goes for current consumption rather than agricultural production.

The administrative capacity to cope with such institutional problems is severely limited. The government is preoccupied with simply staying in power and maintaining peace in the cities. Local leadership and administrative ability in rural areas is sadly lacking. Bureaucratic red tape discourages progress. Those reluctant to delegate responsibility are complemented by those reluctant to accept it. The sheer size of the problems and the limitations imposed by the resources available stifle change.

IV. Production Shortfall in 1985

To forecast Bangladesh's 1985 foodgrain demand and production, a linear difference equation simulation model was developed. Several values of the production and population growth rates were used in the simulation. A description of the model is contained in the appendix.

During the period FY 1950-74, Bangladesh's foodgrain production grew at an annual trend rate of 2.2%.* For

* All trend rates are calculated by fitting an exponential regression curve and are therefore estimates of the trend of production rather than absolute production growth rates. By emphasizing the trend of production instead of the magnitude of increase, the rates presented are more relevant to future projections.

estimating future growth, however, the period FY 1971-74 was omitted because the disruptions resulting from Bangladesh's independence struggle are assumed to have been a one-time occurrence. In the period FY 1950-70 the growth trend for foodgrain production was 2.6% a year. During the 1950s neglect of East Pakistan in general and its agriculture in particular is reflected in a 0.6% yearly growth trend of foodgrain output. The growth trend in the 1960s increased to 2.7%. Although weather conditions are the most important factor in foodgrain production in any one year, projections of production over the long term can with impunity assume a normal distribution of weather variations over the years. While this assumption is not valid for many regions of the world, there is at present no convincing evidence that the dimensions of the annual monsoon are dependent on weather conditions of previous years. Changes in government policy, however, can have a profound effect on the growth of the agricultural sector. Therefore, five alternative growth trend rates for foodgrain production are used -- 2.0%, 2.5%, 3.0%, 3.5%, and 4.0%. While all are within Bangladesh's capability, a range of 2.5% to 3.0% is most likely without drastic changes in the government's outlook toward agriculture.

In estimating demand for foodgrains in 1985, population growth and changes in per capita income are considered. Since

disagreement exists on Bangladesh's present population growth rate, both 3.09% and 3.3% are used -- the former being the official estimate of the Bangladesh government and the latter being closer to that generally accepted by demographers. Population in mid-1985 would be 112.9 million using 3.09% or 115.5 million using 3.3%.

Change in per capita income is estimated from two sets of data. First, to estimate future GNP, the past growth rates of real GDP for East Pakistan during several periods were examined. During the period FY 1950-70 growth trend rate of real GDP was 3.0% with a similar acceleration in the trend rate in the latter decade -- the trend rate for the 1950s was 1.5% and for the 1960s, 4.3%. Second, recognizing that foodgrain production is a major determinant of GDP, a linear correlation was made to determine the influence that changes in foodgrain production had on changes in GDP.1/ Only the period FY 1950-70 was used because data on Bangladesh's GDP since independence are unavailable. The growth rates of real GDP that correspond to assumed growth rates of foodgrain production are given in Table 5.

The range of projected growth rates of foodgrain production and population growth rates yields a gap between production and demand in 1985 of 1.7 million to 4.7 million tons. However,

1. Equation 4 in Appendix.

assuming present government policy remaining basically unchanged, the more likely range of foodgrain production growth rates of 2.5% to 3.0% yields a gap of 3.3 million to 4.2 million tons. The reaction of the government to the strains that such gaps would entail will determine whether such large gaps are to be allowed to develop. It is likely that persistent gaps in excess of 3 million tons will lead to a sharp altering of priorities in favor of agriculture and a reduction of the gap by 1985.

V. Financing Development and Grain Imports

Economic activity in Bangladesh still has not fully recovered from the 1971 independence struggle. Progress has fallen far short of plans. The Five Year Plan (FY 1973-FY 1978) is faltering. Development allocations in all sectors have been greatly reduced by inflation -- now running at about 20% a year. Additional revenue will be difficult to raise. Farm income, the major potential source of new revenue, remains virtually untaxed, and there is considerable political resistance to taxing it. Funds for agricultural development will remain scarce.

Worldwide increases in petroleum, fertilizer, and foodgrain prices have greatly aggravated Bangladesh's chronic balance of payments problems. These three imports alone will just about equal this year's expected export earnings of about $600 million --

some foodgrain and fertilizer imports, however, will come in under aid agreements. Raw materials and spare part imports are needed to increase industrial production and exports. Exports cannot finance increased import costs as export prices are increasing much more slowly than import prices. Chronic balance of payments strictures are likely to continue. Bangladesh will be unable to pay for increased foodgrain imports without more foreign aid.

APPENDIX

Bangladesh Foodgrain Model

The model is described as follows:

(1) $$F_{t+1} = F_t \ (1+\alpha/100)$$

(2) $$P_{t+1} = P_t \ (1+\beta/100)$$

(3) $$G_{t+1} = G_t \ (1+\gamma/100)$$

(4) $$\gamma = 2.39336 + (0.29698)\alpha$$

(5) $$I_t = G_t/P_t$$

(6) $$D_t = aI_t$$

(7) $$T_t = D_t P_t$$

where α = Growth rate of foodgrain production (%)

β = Growth rate of population (%)

F_t = Foodgrain production in time t (metric tons)

P_t = Population in time t (people)

G_t = Gross domestic production in time t (Taka)

γ = Growth rate of gross domestic product (%)

I_t = Gross domestic product per capita in time t (Taka/Person)

a = a constant (metric ton/unit of value)

and initial values are:

α = 2.0, 2.5, 3.0, 3.5, and 4.0

β = 3.09 and 3.3

$F_o = 12.01 \times 10^6$ metric tons

$P_o = 79.6 \times 10^6$ people

I_o = 283 takas/person

D_o = .177 metric tons/person

$G_o = 2.253 \times 10^{10}$ takas

The basic assumptions of the model are:

a. The growth rate of foodgrain production is an exogenous variable. Several values of the growth rate are used in the model, based upon the historical data and judgments on realizable potential over the next decade.

b. The growth rate of population is an exogenous variable.

c. The growth rate of Gross Domestic Product (GDP) is a linear function of the growth rate of foodgrain production.

d. Foodgrain demand is a function of population and GDP per capita. The income elasticity of demand is assumed to be .45.

Equation 4 postulates a linear relationship between the GDP growth rate and the foodgrain production growth rate. That is, equation 4 implicitly assumes that the growth of GDP can be attributed to the growth of the foodgrain sector plus the growth of an independent residual sector of the economy. The growth rates, .29698α of the foodgrain sector and 2.39386 of the residual sector, were determined by linear regression techniques. R^2, a measure of how well the function fits historical data, is equal to .68731.[1/] This value of R^2 indicates that at the two

1. A perfect fit to historical data yields a value of 1.

sector level of aggregation, some precision in the estimate of the GDP growth rate is lost. A better fit of the historical data can be attained by disaggregating the residual sector into several independent sectors. However, the purpose of this exercise is to demonstrate the effects of different foodgrain production growth rates on the gap between domestic production and demand for foodgrains in 1985. Therefore, an attempt to disaggregate the model and predict changes in several independent sectors of the economy is not justified by the marginal gain in the value of R^2.

Since the model extrapolates time trends, the model is simulated by exogenously varying the future foodgrain production growth rate over a range of foodgrain production growth rates. The results show a wide range of output. However, past growth rates are not necessarily indicative of future growth rates, especially since the region has now gained its independence from Pakistan. Although the growth rate during the 1950s was only 0.6%, there is little chance that this will be repeated without a very abnormal series of natural disasters. Now that the Bengalis are masters of their own government, agriculture should never again be as neglected as it was during the 1950s. On the other hand, the acceleration in the 1960s also cannot be blindly projected into the future. An increase in the growth rate from 0.6% in the 1950s to 2.7% in the 1960s does not validate an assumption that the growth rate will accelerate to 4.8% in the 1970s.

Table 1

Bangladesh: Foodgrain Production, FY 1948-74[1/]

million metric tons

Fiscal Year	Aus Rice	Aman Rice	Boro Rice	Wheat	Total[2/]
1948	1.45	5.06	0.32	0.02	6.86
1949	1.43	6.09	0.27	0.02	7.82
1950	1.27	5.84	0.39	0.02	7.52
1951	1.82	5.36	0.28	0.02	7.48
1952	1.62	5.19	0.34	0.02	7.17
1953	1.68	5.41	0.36	0.02	7.48
1954	2.19	5.84	0.35	0.02	8.40
1955	1.99	5.35	0.37	0.03	7.74
1956	1.82	4.32	0.34	0.02	6.51
1957	2.19	5.88	0.24	0.02	8.34
1958	2.12	5.24	0.36	0.02	7.74
1959	1.59	5.05	0.40	0.03	7.06
1960	2.13	6.08	0.41	0.03	8.65
1961	2.54	6.68	0.46	0.03	9.70
1962	2.37	6.76	0.49	0.04	9.66
1963	2.24	6.14	0.49	0.04	8.95
1964	2.70	7.41	0.52	0.03	10.66
1965	2.54	7.38	0.58	0.03	10.53
1966	3.01	6.91	0.63	0.04	10.58
1967	2.69	6.01	0.84	0.06	9.61
1968	3.11	6.92	1.13	0.06	11.22
1969	2.73	6.98	1.64	0.09	11.44
1970	3.01	7.06	1.93	0.10	12.11
1971	2.91	6.01	2.23	0.11	11.16
1972	2.38	6.06	1.81	0.10	10.05
1973	2.31	5.66	2.13	0.10	10.36
1974[3/]	2.54	6.94	2.43	0.10	12.01

1. Ending 30 June of stated year.
2. Columns may not add due to rounding.
3. Preliminary.

Table 2

Bangladesh: Area Planted to Rice, FY 1948-74[1/]
(million acres)

Fiscal Year	Aus Rice	Aman Rice	Boro Rice	Total[2/]
1948	4.50	13.35	0.76	19.01
1949	4.75	13.86	0.81	19.42
1950	4.67	14.01	0.84	19.53
1951	5.26	13.95	0.80	20.01
1952	5.45	14.03	0.83	20.30
1953	5.50	14.44	0.84	20.78
1954	6.32	14.85	0.84	20.01
1955	6.03	14.45	0.86	21.34
1956	5.82	12.99	0.69	19.49
1957	5.99	13.38	0.69	20.06
1958	5.79	13.63	0.82	20.24
1959	5.65	13.15	0.85	19.64
1960	5.95	14.29	0.92	21.15
1961	6.30	14.58	1.01	21.89
1962	5.87	14.08	1.01	20.96
1963	6.19	14.22	1.07	21.48
1964	6.59	14.60	1.07	22.26
1965	6.65	15.11	1.05	22.81
1966	7.32	14.67	1.14	23.13
1967	6.97	14.06	1.18	22.21
1968	8.22	14.68	1.53	24.44
1969	7.66	14.40	2.02	24.07
1970	8.46	14.84	2.18	25.49
1971	7.89	14.18	2.43	24.49
1972	7.42	13.40	2.40	23.02
1973	7.2	14.1	2.4	23.8
1974[3/]	7.7	14.7	2.6	25.0

1. Ending 30 June of stated year.
2. Columns may not add due to rounding.
3. Estimate.

Table 3

Bangladesh: Average Yield of Rice Crops, FY 1948-74[1]/
(pounds per acre)

Fiscal Year	Aus Rice	Aman Rice	Boro Rice	Total
1948	655	837	940	794
1949	644	969	739	885
1950	601	918	1,007	847
1951	762	847	783	822
1952	655	816	895	776
1953	674	826	940	790
1954	762	867	918	839
1955	726	816	962	796
1956	691	735	1,086	734
1957	807	969	772	914
1958	807	747	985	841
1959	619	847	1,029	789
1960	789	939	974	898
1961	888	1,01	996	974
1962	888	1,158	1,078	1,012
1963	797	952	1,007	910
1964	904	1,118	1,067	1,052
1965	843	1,077	1,221	1,015
1966	893	1,038	1,218	1,001
1967	851	943	1,576	948
1968	834	1,039	1,727	1,007
1969	785	1,069	1,792	1,039
1970	784	1,049	1,953	1,039
1971	813	934	2,024	1,003
1972	707	997	1,663	962
1973	707	885	1,957	960
1974[2]/	727	1,041	2,060	1,059

1. Ending 30 June of stated year.
2. Estimated.

Table 4

Bangladesh: Foodgrain Imports, FY 1949-74[1]

(thousand metric tons)

Fiscal Year	Rice			Wheat and Other Grains			All Food-grains
	West Pakistan	Other Countries	Total	West Pakistan	Other Countries	Total	
1949	86	20	106	N.A.	—	N.A.	N.A.
1950	119	43	162	N.A.	—	N.A.	N.A.
1951	29	—	29	N.A.	—	N.A.	N.A.
1952	74	—	74	N.A.	—	N.A.	N.A.
1953	67	—	67	10	—	10	77
1954	49	—	49	21	—	21	60
1955	2	—	2	17	—	17	19
1956	12	55	67	31	9	40	107
1957	3	541	544	58	41	99	643
1958	134	421	555	27	100	127	682
1959	287	182	469	20	7	27	496
1960	83	360	443	33	148	181	624
1961	104	382	586	14	234	248	834
1962	22	203	225	37	195	232	457
1963	248	245	493	69	917	986	1,479
1964	187	143	330	9	657	666	996
1965	22	62	84	68	250	318	402
1966	278	48	326	23	529	552	878
1967	242	191	433	84	716	800	1,233
1968	166	150	316	25	674	699	1,015
1969	191	66	257	193	739	932	1,189
1970	410	120	530	163	930	1,093	1,623
1971	313	787	1,100	27[2]	854	881	1,981
1972 [2]	—	500	500	—	1,350	1,350	1,850
1973	—	385	385	—	2,500[2]	2,500	2,885
1974 [2]	—	83	83	—	2,000	2,000	2,083

1. Ending 30 June of stated year.
2. Estimated.

Table 5

Bangladesh: Projected Foodgrain Situation in FY 1985

Annual Growth Rates (%)			Output (million metric tons)		
Population (β)	Foodgrain Production (α)	Real GNP (γ)	Foodgrain Demand (T_t)	Foodgrain Production (F_t)	G
3.09	2.0	2.99	19.6	14.9	4.7
3.09	2.5	3.14	19.7	15.8	4.0
3.09	3.0	3.28	19.9	16.6	3.3
3.09	3.5	3.43	20.0	17.5	2.5
3.09	4.0	3.58	20.2	18.5	1.7
3.3	2.0	2.99	19.8	14.9	4.9
3.3	2.5	3.14	20.0	15.8	4.2
3.3	3.0	3.28	20.1	16.6	3.5
3.3	3.5	3.43	20.3	17.5	2.7
3.3	4.0	3.58	20.4	18.5	1.9

NOTE: Rows may not add across because of rounding.